PATENT APPLICATION

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

In re application of

Yoji OKAZAKI, et al.

Appln. No.: 09/659,456

Confirmation No.: 5835

Filed: September 11, 2000

Docket No: Q58705

Group Art Unit: 2815

Examiner: Joseph H. Nguyen

For: LASER APPARATUS IN WHICH GaN-BASED COMPOUND SURFACE-EMITTING SEMICONDUCTOR ELEMENT IS EXCITED WITH GaN-BASED COMPOUND SEMICONDUCTOR LASER ELEMENT

APPELLANTS' BRIEF ON APPEAL UNDER 37 C.F.R. § 1.192

MAIL STOP APPEAL BRIEF - PATENTS
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

In accordance with the provisions of 37 C.F.R. § 1.192, Appellant submits the following:

I. REAL PARTY IN INTEREST

The real party in interest in this appeal is the Fuji Photo Film Co., Ltd. The assignment was recorded on September 11, 2000, at Reel 11091, Frame 608.

II. RELATED APPEALS AND INTERFERENCES

There are no known appeals or interferences that would affect the outcome of this appeal.

III. STATUS OF CLAIMS

Claims 1-9, 28-36, 55-58 remain pending in the application. Claims 10-27 and 37-54 have been withdrawn from further consideration at this time, pursuant to the Response filed on

October 28, 2002. Claims 1-9, 28-36, and 55-58 are rejected under 35 U.S.C.§103(a) as being unpatentable over Mooradian et al. (U.S. Patent No. 5,461,637) in view of Ishikawa et al. (U.S. Patent No. 6,359,919 B1) ("Ishikawa").

IV. STATUS OF AMENDMENTS

The modifications submitted in the Amendment of September 15, 2003, have not been entered. The text of the claims on appeal are set forth in the attached Appendix.

V. SUMMARY OF THE INVENTION

The Appellants' invention relates to a laser apparatus using a semiconductor element. The Appellants' invention includes a semiconductor laser element and a surface-emitting semiconductor element. Specification, page 4, lines 9-18. Specifically, the invention includes a semiconductor laser element having a first active layer made of a GaN-based compound which emits a first laser light, and a surface-emitting semiconductor element having a second active layer made of a GaN-based compound which is excited by the first laser light, and then emits a second laser light. Page 4, lines 9-18. In another embodiment, the surface-emitting semiconductor element may comprise a layered structure formed of a plurality of semiconductor layers made of a plurality of GaN-based compounds, and a pair of mirrors are arranged on both sides of the layered structure in the direction of the elevation of the semiconductor layers. Page 9, lines 19-24.

VI. ISSUES

Whether the rejection of claims 1-9, 28-36, and 55-58 under 35 U.S.C.§103(a) as being unpatentable over Mooradian in view of Ishikawa should be withdrawn.

VII. GROUPING OF CLAIMS

For the sole ground of rejection, the claims do not stand or fall together. Rather, the claims should be considered in the Groups as follows.

Group I: Claims 1-9, 28-36, 57, and 58.

Group II: Claims 55 and 56.

VIII. ARGUMENTS

As an initial matter, Appellants submit that the claims do not stand or fall together but rather should be considered in the groupings set out in Section VII. In particular, claims 55 and 56 describe the semiconductor laser element as being a broad area type semiconductor laser element, thereby providing improved efficiencies.

Turning to the references, Mooradian relates to an apparatus and method for producing laser radiation from a vertical cavity semiconductor laser. Mooradian discloses an optical pump source and a semiconductor laser. The optical pump source electrically or optically pumps the semiconductor laser. Col. 1, lines 32-34. The semiconductor laser includes a quantum well region formed over a semiconductor substrate. Col. 1, lines 29-30. A first reflective surface is formed over the quantum well region, and a second reflective surface is formed over the substrate, opposite the first reflective surface to form a laser cavity. Col. 1, lines 27-29, lines 30-

32. Thermal lensing effect occurs when the quantum well region is optically pumped by the optical pump source. Col. 1, lines 47-57.

Ishikawa relates to a gallium nitride-based compound semiconductor laser. In addition to other layers, a p-GaN buried layer and a contact layer through which a current is injected into the opening portion of the current blocking layers and which are larger in area than the opening portion are formed. Col. 10, lines 46-51 and 58-63.

Group I: Mooradian and Ishikawa do not teach a surface-emitting semiconductor element having a second active layer made of a GaN-based compound

The Examiner maintains that Mooradian discloses in Fig. 1 a laser apparatus comprising a surface emitting semiconductor element having a second active layer 22 made of a GaN based compound being excited with said first laser light and emitting second laser light 30. Appellants submit that there is no express teaching of using GaN in Mooradian, as recited in claims 1 and 28. Specifically, there is no suggestion or motivation for a "surface-emitting semiconductor element having a second active layer made of a GaN-based compound," as recited in claims 1 and 28, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art. Although Mooradian discloses that "[p]referred substrate materials and quantum-well materials are, but not restricted to binary, ternary, or quaternary compounds taken from the Group III-V [periodic] table of elements," (col. 5, lines 6-9), such a disclosure in the context of what is taught by Mooradian does not suggest or provide motivation for the claimed second active layer.

One skilled in the art would not have been led to use GaN specifically from Group III-V because of the apparent incompatibility of GaN-based materials with what is disclosed by Mooradian. In Mooradian, the generation of heat in the semiconductor material is important in changing the refractive index of the semiconductor material:

> As the laser is pumped, the absorbed pump light causes heating of the semiconductor material and therefore a thermal lensing effect within the laser cavity. The thermal lens is caused by the thermally induced increase in refractive index or an actual physical bulging of the material surface due to thermal expansion. The thermal lens causes an effective mirror radius of curvature which is a function of absorbed pump power, size of the pumped spot, <u>thermal conductivity of the material</u>, heat sinking conditions, refractive index variation with temperature, and thermal expansion coefficient.

Col. 1, lines 57-68 (emphasis added); *see,* col. 3, lines 5-9 (lensing effect shown by dot-dashed lines 26 in Figure 1). The thermally-induced lensing effect in the semiconductor substrate 16 automatically stabilizes the transverse spatial mode resonating within the laser cavity. Col. 3, lines 8-10. Further, Mooradian teaches the use of GaAs-based materials for the semiconductor substrate. Col. 5, lines 6-9. GaAs-based materials, however, have thermal conductivity levels which are approximately three times lower than the thermal conductivity of GaN-based materials (45.8 W/m*K for GaAs-based materials versus 130 W/m*K for GaN-based materials. Specification, page 6, lines 2-13).

As a consequence, one of ordinary skill in the art would not have chosen GaN from the Group III-V materials because the marked differences in thermal conductivity would likely effect the properties of the thermal lens and subsequent stabilization of the transverse spatial mode resonating within the cavity. Although the prior art can be modified or combined to reject claims

as prima facie obvious as long as there is a reasonable expectation of success, *In re Merck & Co., Inc.*, 800 F.2d 1091, 231 USPQ (BNA) 375 (Fed. Cir. 1986), the difference in thermal conductivity ultimately leads to the conclusion that there is no reasonable expectation of success given the importance of heat in the thermal lensing effect.

Moreover, the general teaching of Group III-V materials does not teach the more specific structure of the semiconductor as claimed. The Examiner is not free to assume interchanging of elements appropriate in Mooradian when specific combinations of GaAs and InP are discussed. *See In re Jones*, 958 F.2d 347, 350, 21 USPQ2d (BNA) 1941, 1943 (Fed. Cir. 1992).

Lastly, claims 1 and 28 are patentable because of the following advantageous effects obtained by using the GaN substrate in the laser apparatus employing a surface-emitting semiconductor element, as previously noted in the September 15, 2003 Amendment Under 37 C.F.R. § 1.116:

1) Since the GaN substrate is transparent to the excitation laser light, it is possible to excite the surface-emitting semiconductor element through the substrate. Heat generated in the surface-emitting element, however, can be easily dissipated due to the high thermal conductivity exhibited by GaN-based materials when compared to GaAs-based materials, as mentioned above. Therefore, beam deformation due to the thermal lens effect or the light is very small.

2) Since the excitation laser light is supplied to the surface-emitting semiconductor element through the substrate as shown in Fig. 8 of the Applicant's

Specification, the superposition of the oscillation mode and the excitation mode can be carried out well, whereby a good laser beam can be obtained without deformation.

3) Further, since heat generation at the second active layer can be suppressed by the use of high-thermal conductivity materials, i.e., GaN-based materials, the lifetime of the laser apparatus can be made long (Specification, page 6, line 23 - page 7, line 9).

For at least the above reasons, claims 1 and 28 are patentable. The remaining claims are patentable based on their dependency.

Group II: Claims 55 and 56 describe structural features that are not taught in Mooradian or Ishikawa

Applicants submit that the Examiner has not established a *prima facie* case of obviousness because the Examiner has failed to show how the claimed broad area type semiconductor laser element, as recited in claims 55 and 56, is taught or suggested by the references. Rather, the Examiner merely engages in an unsubstantiated characterization of the references as disclosing what is recited in claims 55 and 56. *See* Final Office Action at page 3. Because the Examiner not shown how the broad area type semiconductor laser element is taught or suggested by the references and the Applicants have not found any teaching or suggestion of a broad area type semiconductor laser element in Mooradian or Ishikawa, claims 55 and 56 are patentable.

IX. CONCLUSION

In view of the foregoing, Appellants respectfully requests that the § 103 rejections be withdrawn and that claims 1-9, 28-36, 55-58 should be passed to issue.

The present Brief on Appeal is being filed in triplicate. Unless a check is submitted herewith for the fee required under 37 C.F.R. §1.192(a) and 1.17(c), please charge said fee to Deposit Account No. 19-4880.

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APPENDIX

CLAIMS 1-9, 28-36, 55-58 ON APPEAL:

Claim 1. A laser apparatus comprising:

a semiconductor laser element having a first active layer made of a GaN-based compound, and emitting first laser light; and

a surface-emitting semiconductor element having a second active layer made of a GaN-based compound, being excited with said first laser light, and emitting second laser light.

Claim 2. A laser apparatus according to claim said second active layer includes a plurality of quantum wells.

Claim 3. A laser apparatus according to claim 2, wherein said second active layer includes twenty or more quantum wells.

Claim 4. A laser apparatus according to claim 1, wherein said first active layer is made of an InGaN or GaN material, and said second active layer is made of an InGaN material.

Claim 5. A laser apparatus according to claim 4, wherein said second active layer includes a plurality of quantum wells.

Claim 6. A laser apparatus according to claim 5, wherein said second active layer includes twenty or more quantum wells.

Claim 7. A laser apparatus according to claim 1, wherein 1, wherein said first active layer is made of an InGaN or GaN material, and said second active layer is made of a GaNAs or InGaNAs material.

Claim 8. A laser apparatus according to claim 7, wherein said second active layer includes a plurality of quantum wells.

Claim 9. A laser apparatus according to claim 8, wherein said second active layer includes twenty or more quantum wells.

Claim 28. A laser apparatus comprising:

a semiconductor laser element having a first active layer made of a GaN-based compound, and emitting first laser light;

a surface-emitting semiconductor element being excited with said first laser light, emits second laser light, and having a second active layer made of a GaN-based compound and a first mirror arranged on one side of said second active layer; and

a second mirror arranged outside said surface-emitting semiconductor element so that said first and second mirrors form a resonator.

Claim 29. A laser apparatus according to claim 28, wherein said second active layer includes a plurality of quantum wells.

Claim 30. A laser apparatus according to claim 29, wherein said second active layer includes twenty or more quantum wells.

Claim 31. A laser apparatus according to claim 28, wherein said first active layer is made of an InGaN or GaN material, and said second active layer is made of an InGaN material.

Claim 32. A laser apparatus according to claim 31, wherein said second active layer includes a plurality of quantum wells.

Claim 33. A laser apparatus according to claim 32, wherein said second active layer includes twenty or more quantum wells.

Claim 34. A laser apparatus according to claim 28, wherein said first active layer is made of an InGaN or GaN material, and said second active layer is made of a GaNAs or InGaNAs material.

Claim 35. A laser apparatus according to claim 34, wherein said second active layer includes a plurality of quantum wells.

Claim 36. A laser apparatus according to claim 35, wherein said second active layer includes twenty or more quantum wells.

Claim 55. A laser apparatus according to claim 1, wherein the semiconductor laser element is a broad area type semiconductor laser element having output power substantially in a range of 1 to 10 watts and the laser apparatus generates output power up to several watts in a stable fundamental transverse mode.

Claim 56. A laser apparatus according to claim 28, wherein the semiconductor laser element is a broad area type semiconductor laser element having output power substantially in a range of 1 to 10 watts and the laser apparatus generates output power up to several watts in a stable fundamental transverse mode.

Claim 57. A laser apparatus according to claim 1, wherein the GaN-based compound in the first active layer of the semiconductor laser element is an InGaN material for emitting an excitation light in the 410 nm band, the surface-emitting semiconductor element further comprises a GaN substrate, and the first laser light is supplied to the surface-emitting semiconductor laser element through the GaN substrate.

Claim 58. A laser apparatus according to claim 28, wherein the GaN-based compound in the first active layer of the semiconductor laser element is an InGaN material for emitting an excitation light in the 410 nm band, the surface-emitting semiconductor element further comprises a GaN substrate, and the first laser light is supplied to the surface-emitting semiconductor laser element through the GaN substrate.